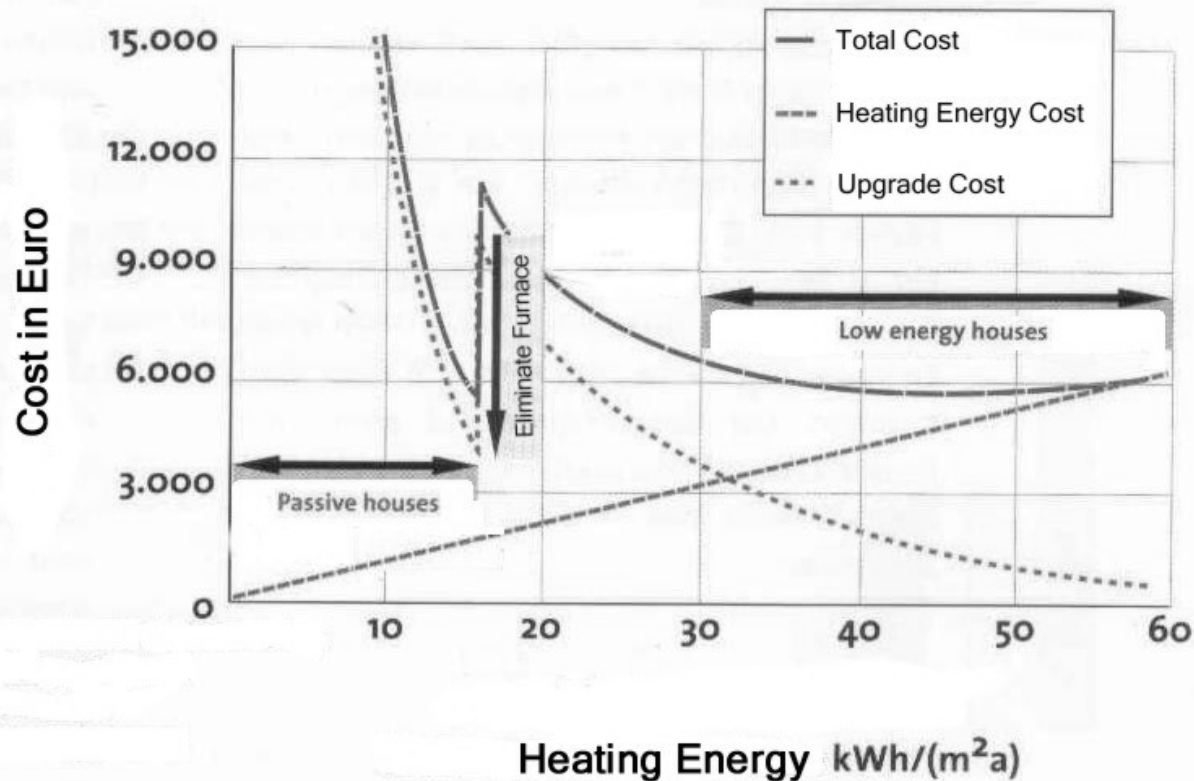


U.S. Passive House Projects – Net Plus Energy Homes

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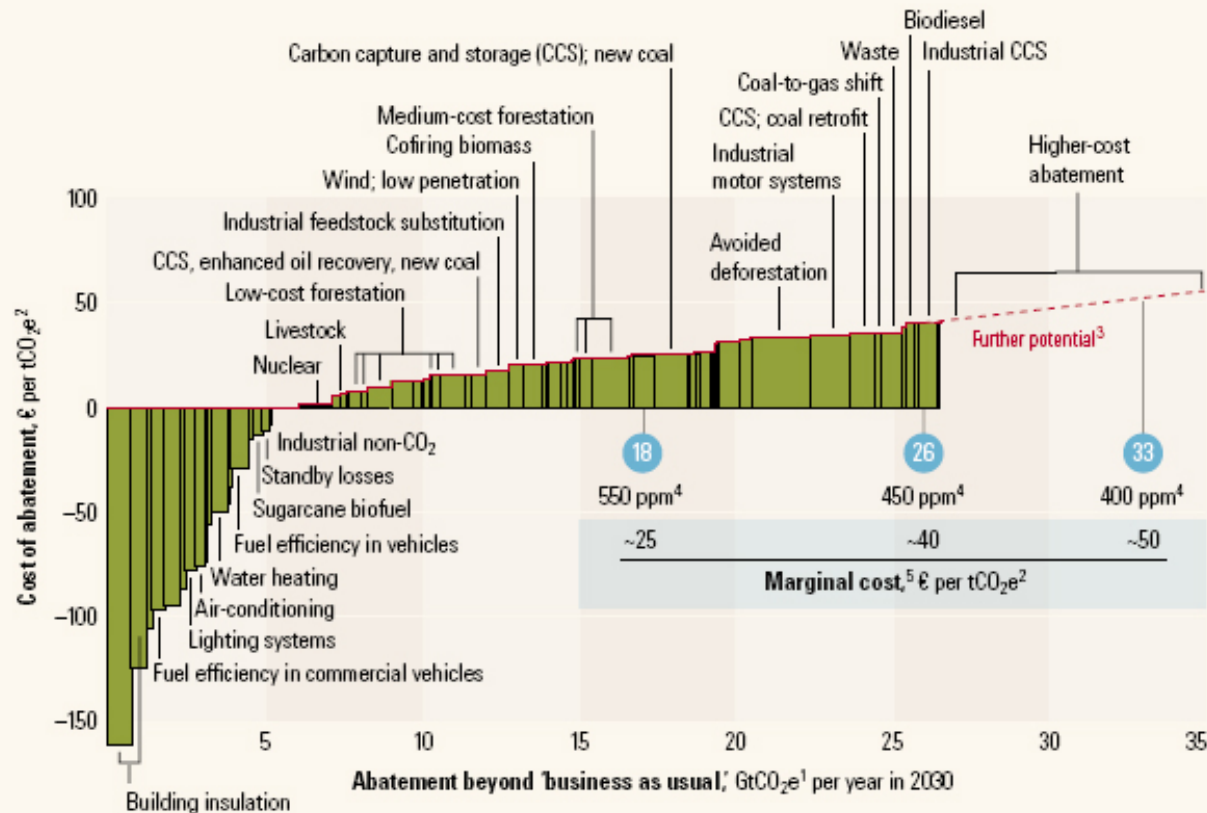


Passive House - “WHOLE > SUM:PARTS”



Global cost curve for greenhouse gas abatement measures beyond 'business as usual'; greenhouse gases measured in GtCO₂e¹

● Approximate abatement required beyond 'business as usual,' 2030



¹ GtCO₂e = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.

² tCO₂e = ton of carbon dioxide equivalent.

³ Measures costing more than €40 a ton were not the focus of this study.

⁴ Atmospheric concentration of all greenhouse gases recalculated into CO₂ equivalents; ppm = parts per million.

⁵ Marginal cost of avoiding emissions of 1 ton of CO₂ equivalents in each abatement demand scenario.

Homes for a Changing Climate—Passive Houses in the U.S.

Homes for a Changing Climate

Passive Houses in the U.S.

by Katrin Klingenberg,
Mike Kernagis, and Mary James



Passive House Institute US

NZE-Workshop, Colorado Springs
Feb 2-3, 2009

Project Data of the Cleveland Farm:

Location	West Tisbury, Massachusetts
Region and climate	<i>Latitude: 41°22'48"</i> <i>Longitude: 70°40'12"</i> <i>Elevation: 89 ft</i> Cold climate
Heating degree-days/ cooling degree-days	5,713/436
Year of construction	2007–2008
Typology	Single-family residence
Finished floor area	422 m ² (4,544 ft ²)
Architect	Craig Buttner, Architect P.C.
Builder	Clancy Construction
Project Cost	\$1.2 Million (\$264 per finished sq ft)

The Cleveland Farm House by the Numbers based on the PHPP 2004 calculations:

specific heating energy requirement: **14.9 kWh/m²a (4.7 kBtu/ft²/yr)**

specific primary energy requirement: **43 kWh/m²a (13.6 kBtu/ft²/yr)**

peak heating load: **12.6 W/m² (3.99 Btu/h/ft²)**

airtightness: **0.6 ACH₅₀**

surface area-to-volume ratio (A/V): **1.05**

Active System requirement to become *plus energy*/carbon neutral

5 kW wind turbine

Smith House – 2003, IL



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Project Data for the Smith House:

Location	Urbana, Illinois
Region and climate	<i>Latitude: 40.116N</i> <i>Longitude: 88.243W Elevation: 738 ft</i> Cold climate
Heating degree-days/ cooling degree-days	6,359/888
Year of construction	2002-03
Typology	Single-family residence
Finished floor area	111 m2 (1,200 square feet, including double story space)
Owner/Designer	Katrin Klingenberg/Nicolas Smith
Builder	Edward Sindelar Chicago
Project Cost	\$135,000 (\$112 per finished sq ft)



The Smith House by the Numbers

based on the PHPP 2004 calculations:

specific heating energy requirement: 8 kWh/m²a (2.5 kBtu/ft²/yr)

whole-house specific primary energy requirement: 111 kWh/m²a (35.2 kBtu/ft²/yr)

peak heating load: 13.1 W/m² (4.2 Btu/h/ft²)

airtightness: 0.6 ACH₅₀

surface area-to-volume ratio (A/V): 0.74

Active System requirement to become *net zero site energy*

2 kW photovoltaic system (not installed but wired in)

Active System requirement to become *plus energy/carbon neutral*

5 kW photovoltaic system (not installed but wired in)



The BioHaus – 2006, MN



Project Data of the BioHaus:

Location	Bemidji, Minnesota
Region and climate	<i>Latitude:</i> 47°28'14" N <i>Longitude:</i> 94°52'39" W <i>Elevation:</i> 1,350 ft Very cold climate
Heating degree-days/ cooling degree-days	9,869/296
Year of construction	2006
Typology	School building
Finished floor area	401.3 m ² (4,320 ft ²)
Owner	Concordia Language Village
Architect	Stephan Tanner, AIA

The Smith House by the Numbers

based on the PHPP 2004 calculations:

specific heating energy requirement: 13.7 kWh/m²a (4.35 kBtu/ft²/yr)

specific primary energy requirement: 83 kWh/m²a (26.3 kBtu/ft²/yr)

airtightness: 0.18 ACH₅₀

surface area-to-volume ratio (A/V): 0.68

Active System requirement to become *net zero site energy*

3.5 kW PV system (not installed but wired in)

Active System requirement to become *plus energy/carbon neutral*

10.8 kW PV system, planned system : 25 kW PV System

Stanton Residence: Scheduled to be finished in Feb '09, Urbana Illinois





Fairview 1+2 - 2005-07



Passive Houses are feasible for Retrofits!

Tahan Residence, Berkeley CA



Solar Decathlon Winning Entry 2007



University of Darmstadt



Passive House Institute US

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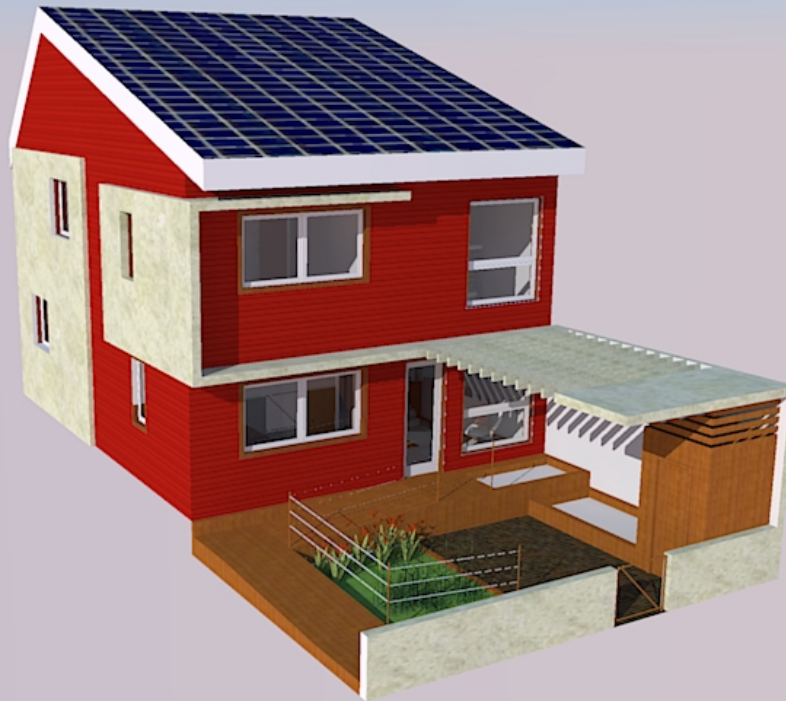
Kerr Avenue, Urbana IL: Carbon-Neutral Passive Townhouses planned for 2009-10



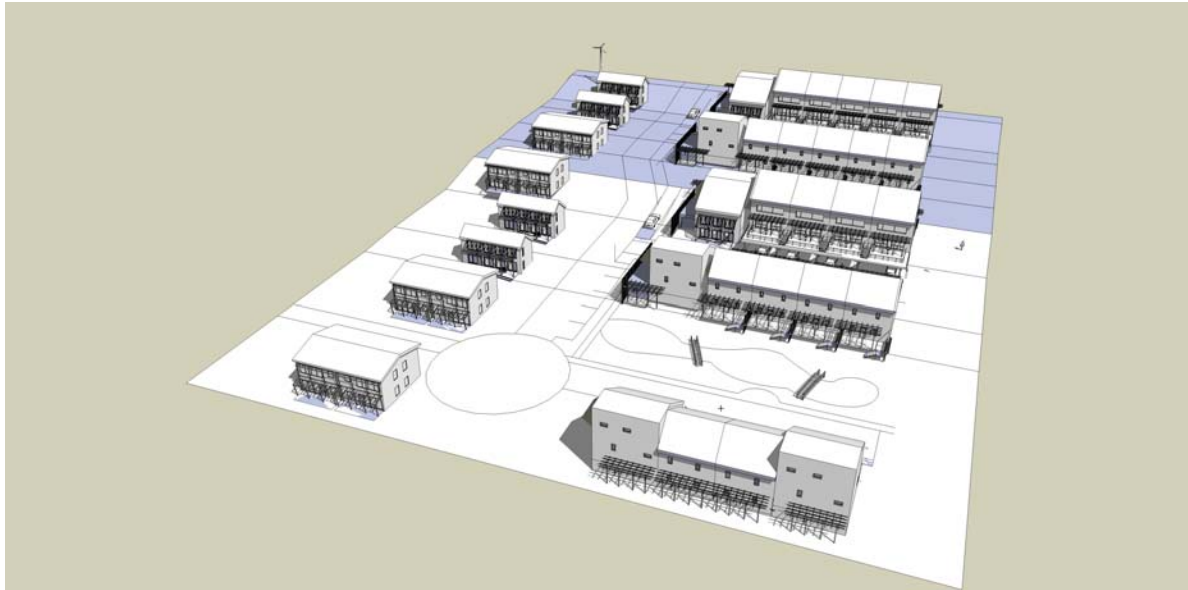
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Kerr Avenue, Urbana IL: Passive Townhouses, PI



Kerr Avenue, Urbana IL: Carbon-Neutral Passive Townhouses planned for 2009-10



Year of Construction: **2008**
 Number of Dwelling Units: **1**
 Enclosed Volume V_e : **353.7** m³
 Number of Occupants: **2.0**

Interior Temperature: **20.0** °C
 Internal Heat Gains: **2.1** W/m²

Utilisation Pattern: Dwelling
 Type of Values Used: Standard

Planned Number of Occupants: **2**
 Design

Specific Demands with Reference to the Treated Floor Area			
Treated Floor Area:	81.6 m ²		
Applied:	Annual Method	PH Certificate:	Fulfilled?
Specific Space Heat Demand:	10 kWh/(m ² a)	15 kWh/(m ² a)	Yes
Pressurization Test Result:	0.6 h ⁻¹	0.6 h ⁻¹	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	94 kWh/(m ² a)	120 kWh/(m ² a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	49 kWh/(m ² a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	118 kWh/(m ² a)		
Heating Load:	24 W/m ²		
Frequency of Overheating:	%	over 25 °C	
Specific Useful Cooling Energy Demand:	17 kWh/(m ² a)	15 kWh/(m ² a)	
Cooling Load:	W/m ²		

Verification:	Annual Method
Specific Space Heat Demand, Annual Method	9.9
Specific Space Heat Demand, Monthly Method	14.8

Heating, Cooling, DHW, Auxiliary and Household Electricity	36.6	94.0	23.6
Total PE Value	94.0 kWh/(m ² a)		
Total Emissions CO ₂ -Equivalent	23.6 kg/(m ² a)		(Yes/No)
Primary Energy Requirement	120 kWh/(m ² a)		Yes

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations with PHPP are attached to this application.

Heating, DHW, Auxiliary Electricity (No Household Applications)	18.2	49.1	12.4
Specific PE Demand - Mechanical System	49.1 kWh/(m ² a)		
Total Emissions CO ₂ -Equivalent	12.4 kg/(m ² a)		

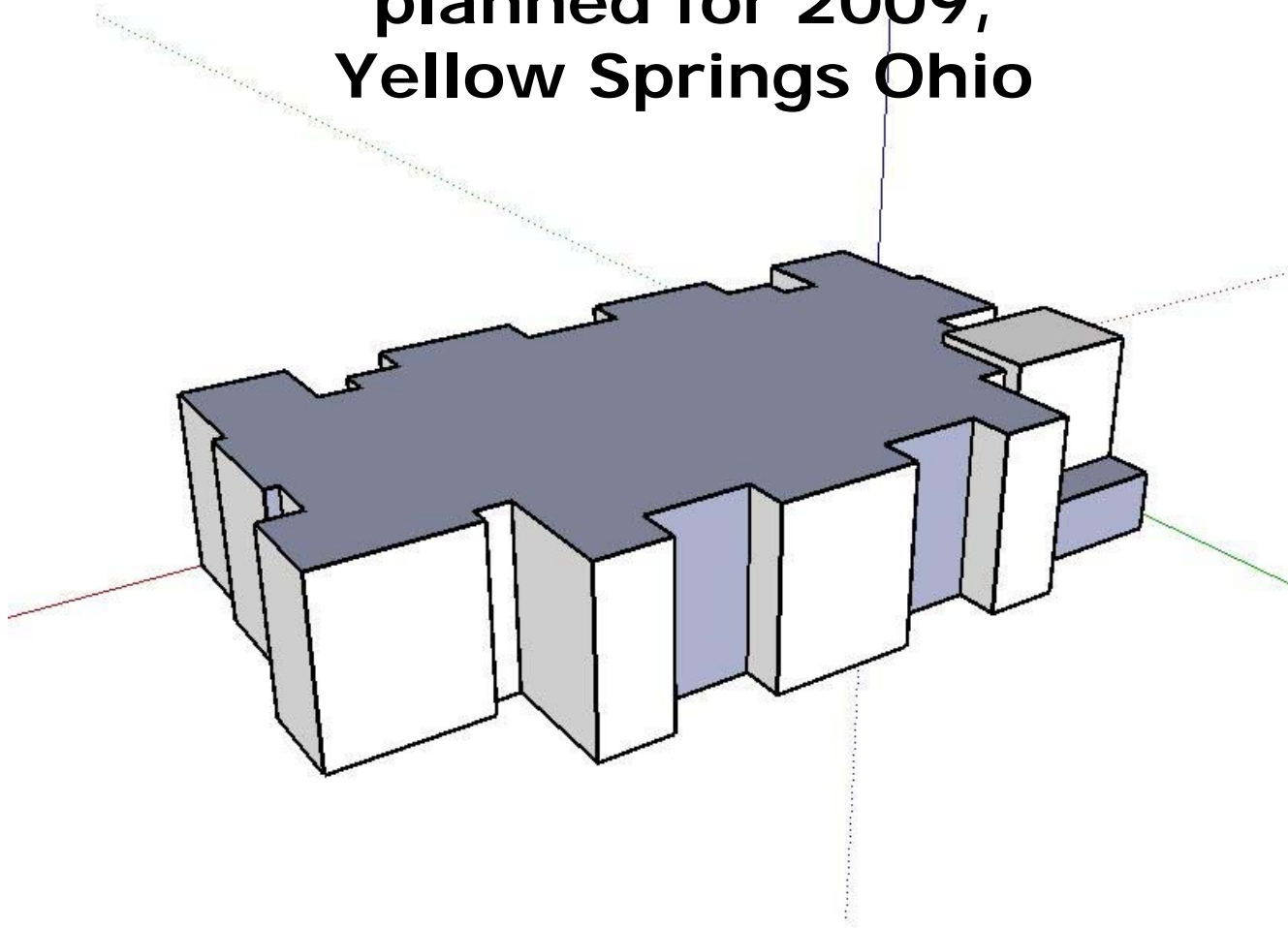
Solar Electricity	kWh/a	PE Value (Savings)	CO ₂ -Emission Factor
Planned Annual Electricity Generation	4800	kWh/kWh	g/kWh
		0.7	250
Specific Demand	58.8	41.2	14.7
PE Value: Conservation by Solar Electricity	117.6 kWh/(m ² a)		
CO ₂ -Emissions Avoided Due to Solar Electricity	25.3 kg/(m ² a)		

PHPP Multifamily Calculation:

- Overall Volume can be used to certify building/meet PH standard
- End house or worst case scenario apartment has to be modeled separately to calculate peak heat/cooling load
- Each Passive Townhouse only needs about 3.5 kW PV array to become net plus energy and carbon-neutral! Cost for PH components: \$16,000 PV after Rebate: \$20,000
- 10% additional cost for PH compared to standard construction, an additional 12.5% for PV



Friends Care Facility: 38 Apartments, planned for 2009, Yellow Springs Ohio



Approx. 250 Unit mixed development, planned for 2009, Boulder, CO

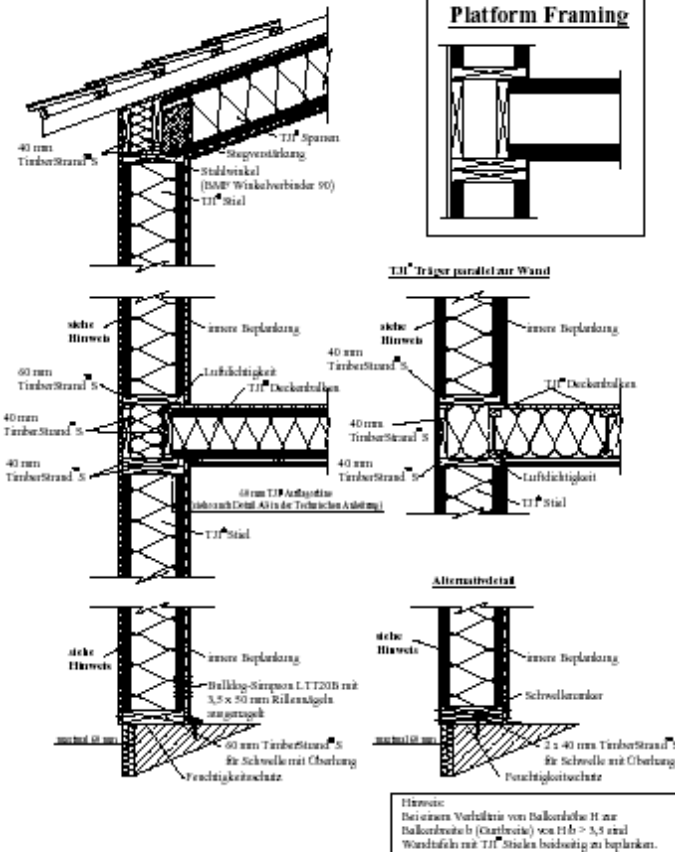


Passive House PHCs/Activities in the U.S.:



What is needed?

- **Professional Training:**
 - Passive House Consultants & Contractors
 - Training, Trade Schools
- **Passive House Components**
 - Insulation
 - Window
 - Wall System etc.





M.A. PH+: Passive House Master of Arts -Architecture

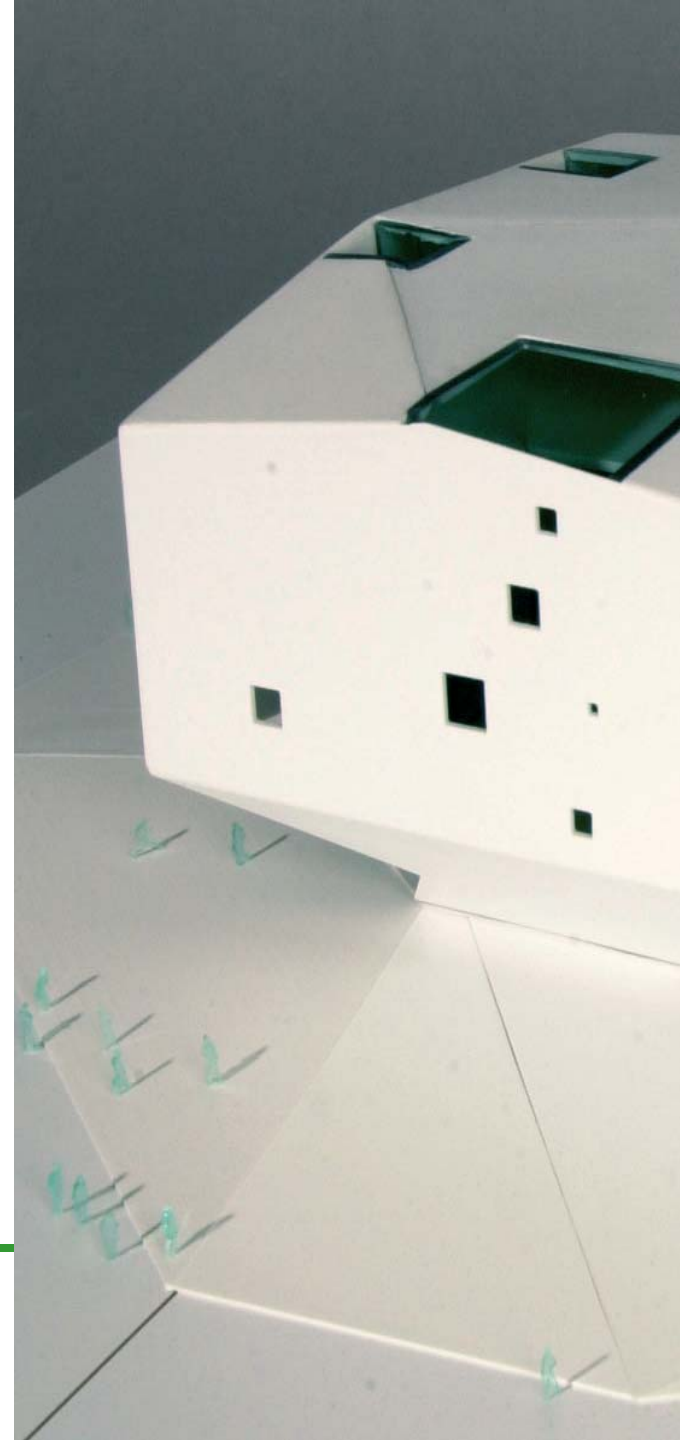
**Passive House Masters Program, first of its
kind in Germany started Sep 2008:**

Fachhochschule Erfurt, Germany

**Partnerships with US schools in the States
Are being pursued in NYC and Chicago.**



Passive House Institute US



Solar Decathlon Winning Entry 2007



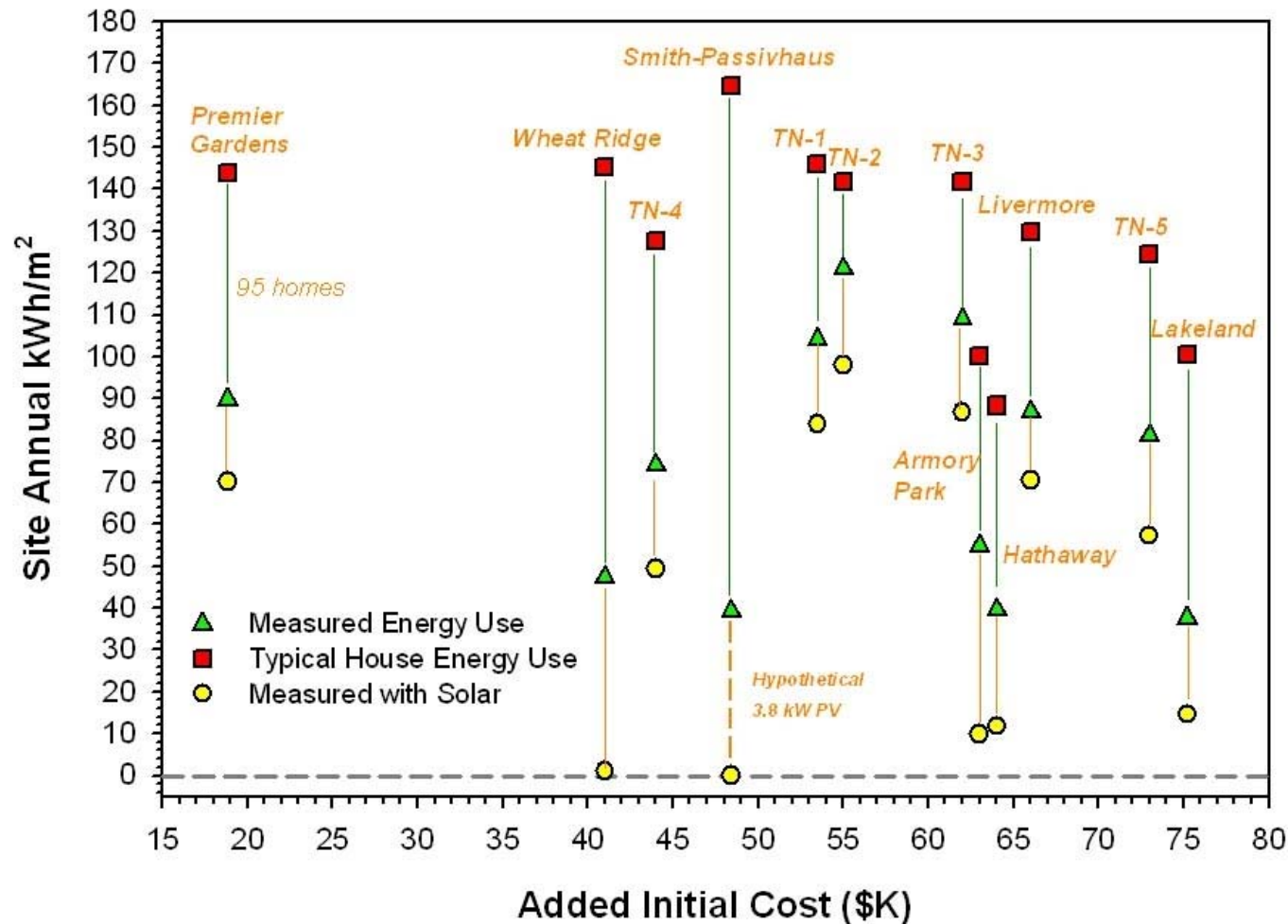
University of Darmstadt



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Cost vs. Measured Total Energy Use of a Compendium of Very Low Energy Homes



Study done by the Florida Solar Energy Center in conjunction with the Lawrence Berkeley National Laboratory, Author: Danny Parker